(57) Carrier, holder, laser cutting device and method for separating semiconductor products using laser light

The invention relates to a carrier and to a holder for supporting and engaging semiconductor products during separating of the products using laser light. The invention also relates to a method for supporting and engaging semiconductor products during separating of the products using laser light.

In the production of semiconductor products it is usual for a large number of products to be brought together in a collective assembly of semiconductor products (which is also referred to for instance as a lead frame). After the greater part of the production steps have been completed, the assembled semiconductor products are separated from each other by a cutting or sawing operation. Use is also made for this purpose, albeit still only on limited scale, of laser cutting technique. Since the separated semiconductor products are being manufactured in increasingly smaller dimensions, it is difficult to position such small components with grippers. In the prior art smaller semiconductor components are separated from an assembly of semiconductor products on which a foil layer is arranged in adhering manner. When the semiconductor components are separated with laser light, the foil remains (at least substantially) intact, so that even after the assembly of semiconductor products has been cut through the semiconductor components are still connected to each other by the foil layer. The problem of positioning semiconductor components of limited dimensions (for instance with a surface area of less than 0.36 mm^2) can thus be solved using the foil. The drawback however is that arranging and removing the foil are costly operations. In addition, the foil material also has the effect of increasing cost price. Yet another drawback is that the separated semiconductor products can be contaminated by for instance glue residues that are left behind.

The international patent application WO 01 75966 describes a method of separating objects by means of a laser and water beam. Prior to cutting, the objects are arranged for this purpose on a carrier provided with adhesive. The laser and water beam is displaced over the object along a contour for cutting out in order to separate the products, whereafter the cut-out products still adhering to the carrier are available for further processing. The carrier can be permeable for laser radiation. A specific embodiment

variant describes a carrier embodied as a mat which makes use, among other things, of underpressure for a further processing of the cut-out products.

The object of the present invention is to simplify and make cheaper the separation of semiconductor products by means of laser cutting.

The invention provides for this purpose a carrier for supporting and engaging semiconductor products during separating of the products using laser light, comprising: a plate provided with a pattern of holes arranged in a flat carrying side of the plate, which plate is manufactured from a material at least substantially not absorbing the laser light. Examples of such materials are glass and ceramic. A material at least partially permeable to laser light will not absorb any energy, or hardly any, from the laser light and will not therefore be damaged under the influence of the laser beam. By means of the pattern of holes an underpressure can be exerted on the assembly of semiconductor products (and, after separation, on the individual components), this being further elucidated hereinbelow. The advantage of glass as material for the plate is that it is not expensive and, in addition, can be readily processed by means of micro-mechanical production techniques (for instance powder blasting). Boro-silicate glass is thus suitable for manufacturing a plate which can be applied in combination with a YAG laser (1064 nm). Another example is the application of zinc selenide (embodied as a ceramic material) to manufacture a plate which can be applied in combination with a CO_2 laser (10600 nm). A further example is the application of calcium fluoride (likewise embodied as a ceramic material) to manufacture a plate which can be applied in combination with a UV laser (354 nm). To be perfectly clear: laser light is understood to mean electromechanical radiation in a single colour, or electromechanical radiation comprising substantially a single wavelength. In this manner carriers can be manufactured with a very large number of holes (up to more than 100 holes per cm^2) with great precision in respect of dimensioning. The use of adhesive foil becomes unnecessary due to the carrier according to the invention, which has the effect of reducing cost and whereby the problem of glue residues being left on semiconductor products is obviated.

In a preferred embodiment of the carrier, the cross-sections through the holes close to the carrying side of the plate are larger than at a distance from the carrying side. This is

the case when the holes have a top angle between 15 and 45°, preferably a top angle of 30°. The surface area of the assembly of semiconductor products on which an underpressure is exerted can thus be enlarged, with the advantage that the assembly of semiconductor products is drawn with a greater force against the plate. This results in improved engaging of the assembly of semiconductor products and the separated components. The pattern of holes will generally be grid-shaped as the semiconductor products are generally also placed in a grid form on the assembly of semiconductor products. After separation of the products, each product must still cover at least one hole of the pattern of holes such that using this covered hole an underpressure is still exerted on the product for positioning thereof. The carrier can have product-related dimensions (in particular the pattern of holes) although it is also possible to envisage that diverse products with the same carrier can be processed, provided account is taken in the design of the placing of the semiconductor products in the assembly of semiconductor products.

The invention also provides a holder for supporting and engaging semiconductor products during separating of the products using laser light, comprising a carrier as described above and means for generating underpressure connecting onto the side of the plate remote from the carrying side. In a preferred variant such means for generating underpressure connecting onto the side of the plate remote from the carrying side are formed by a chamber connecting onto the carrier and an extractor connecting onto the chamber. The means for generating underpressure can be thus connected in simple manner to all holes in the carrier. The chamber is preferably also provided with positioning means for the carrier, so that the carrier can be correctly positioned in simple manner relative to the means for generating underpressure. Also an advantage is that the carrier can thus be mounted for easy exchange with the means for generating underpressure.

The invention furthermore provides a laser cutting device for supporting and engaging semiconductor products during separating of the products using laser light, provided with a holder as described, wherein the laser source is located on the carrying side of the plate. For optimum operation it is recommended that the laser beam comes into direct contact with the assembly of semiconductor products. It must be possible to displace the plate and the laser beam in precisely controllable manner relative to each other with

displacing means in order to thus be able to determine precisely the position of separation of the assembly of semiconductor products.

The invention further provides a method for supporting and engaging semiconductor products during separating of the products using laser light, comprising the processing steps of: A) placing an assembly of semiconductor products for separating onto a flat plate provided with a pattern of holes, B) applying an underpressure to the holes of the pattern of holes such that the assembly of semiconductor products is drawn against the plate, C) directing at least one laser beam onto the assembly and cutting through the assembly where this is desired by means of mutual displacement of the laser source and the flat plate such that each severed semiconductor product is still connected to at least one hole in the flat plate, and D) taking the separated products from the plate. In addition to the advantages already described with reference to the carrier and holder according to the present invention, it is also a great advantage of this method that particular deviations in the dimensioning (warpage) of the assembly of semiconductor products can hereby be compensated. The assembly of semiconductor products often has a form deviating slightly from flat as a result of heating during previous processing steps. By means of the present invention an assembly of semiconductor products which is warped to some extent can be made flat once again before the cutting operation begins. For this purpose the assembly of semiconductor products is preferably drawn against the plate during processing step B) such that possible deviations in the flatness in the contact side of the assembly are removed by the suction of the plate. It will be apparent that this will have a positive effect on the accuracy during separation. For simple removal of the separated products from the plate it is advantageous to first at least partly relieve the underpressure on the holes.

The present invention will be further elucidated with reference to the non-limitative embodiments shown in the following figures, in which:
figure 1 shows a view of the carrier according to the invention,
figure 2 shows a perspective view of a holder according to the invention,
figure 3 is a perspective view of a holder according to the invention with a lead frame placed thereon from which a number of semiconductor products have been released, and
figure 4 shows a view of a cross-section through a part of a carrier.

Figure 1 shows a carrier 1 manufactured from a transparent material which can hardly be activated by laser light. Arranged in carrier 1 is a grid-like pattern of holes 2 built up of individual holes 3 with which an assembly of semiconductor products, not shown in this figure, can be engaged.

Figure 2 shows a holder 4 according to the invention of which a carrier 5 forms part. Holes 6 in carrier 5 are shown schematically. A vacuum chamber 7 is provided with a central opening 8 to which a pump 11 connects via a throughfeed 9 and a pipe 10. By activating pump 11 an underpressure can be generated in vacuum chamber 7, at least when carrier 5 connects onto chamber 7. The consequence is that air will then be drawn in through holes 6. When an assembly of semiconductor products 12 is placed, an underpressure will be exerted on assembly 12 by the holes.

Figure 3 shows a lead frame 13 having a housing 14 injected thereon with which a plurality of semiconductor products (not shown) are encapsulated. Such a unit has already been designated above as an assembly of semiconductor products. Lead frame 13 is sucked down by openings 15 in a carrier 16. It is noted that some of the openings 15 in carrier 16 are not covered by lead frame 13; this is not a problem however, at least when the means for generating an underpressure on the non-visible side of carrier 16 are sufficiently powerful. Also shown in this figure are cutting lines 17 in housing 14 where separation of the individual semiconductor products 18 has taken place.

Finally, figure 4 shows a cross-section through a part of carrier 16, wherein an opening 15 is shown in more detail. On a carrying side 19 of carrier 16 the opening 15 has a larger cross-section than at a greater distance from the carrying side 19. Opening 19 thus forms a kind of cup whereby the area is relatively large over which underpressure can be applied to an assembly of semiconductor products 12 (figure 2) or to already separated products 18 (figure 3). In the case of possible contamination of opening 15, blow air can be carried through opening 15 in a direction opposite to the suction during underpressure situations.